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AN INVESTIGATION OF ENVIRONMENTAL INFLUENCE  
ON THE CREEP BEHAVIOR OF A LOW PRESSURE PLASMA SPRAYED  
NiCoCrAlY ALLOY

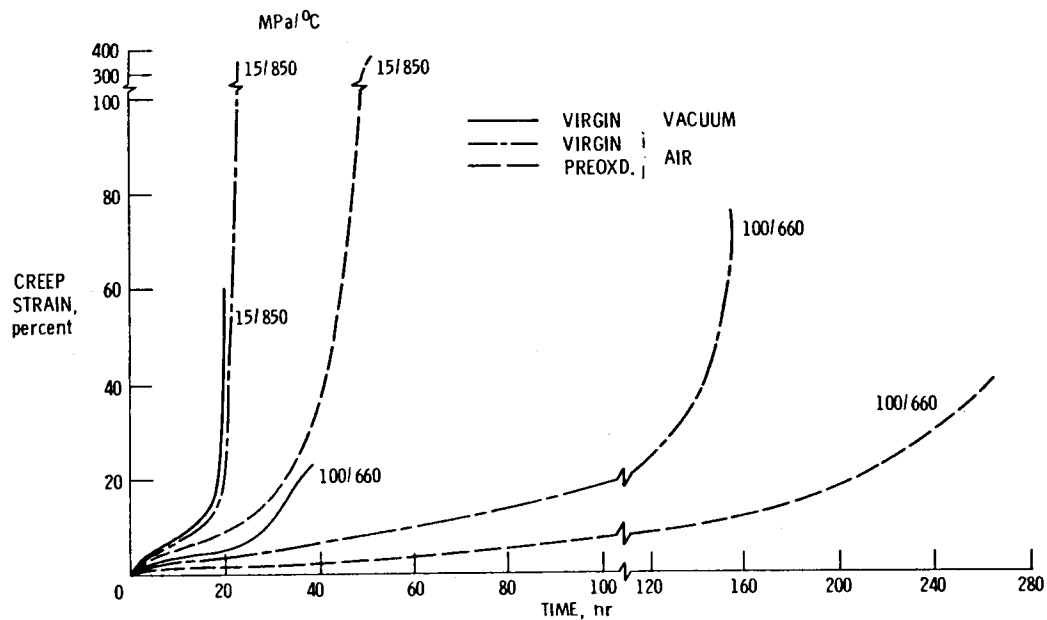
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Low pressure sprayed MCrAlY overlay coatings are currently being used on advanced single crystal superalloy blades for gas turbine engines. Many studies have been made on the influence of coatings on the mechanical properties of superalloys in oxidizing or hot-corroding environments, but very few on the properties of the bulk coating alloy itself. In this study the creep behavior of a typical NiCoCrAlY alloy (PWA 276) has been studied in air and vacuum. The as-received low pressure plasma sprayed NiCoCrAlY plates were heat treated for 4 h at 1080 C followed by 32 h at 870 C, the heat treatment applied to coated superalloy parts. Standard creep specimens 12.7 mm long and 3.2 mm in diameter were then machined. Constant load creep -rupture tests were carried out in air and vacuum at 650, 850, and 1050 C and various initial stresses. In addition, some specimens were preoxidized at 1050 C for 100 h prior to testing.

At 650 and 870 C, rupture lives in vacuum were 2 to 3 times longer in air than in vacuum. The second stage creep rates were independent of test environment, however during tests in air tertiary creep began later, progressed at a lower rate, and continued to a greater strain at fracture than during tests in vacuum. In comparison, preoxidized specimens tested in air exhibited a lower second stage creep rate, a greater time to the onset of tertiary creep, but the same strain at fracture as virgin specimens tested in air. These effects appear consistent with a blunting of the initial surface pores in the material by testing in air or additionally by preoxidation. This would delay the onset of tertiary creep. Also, air appears to blunt the growing cracks during tertiary creep providing lower tertiary creep rates and greater strain to fracture. Further experiment is required to explain the effect of the preoxidation exposure in lowering the second stage creep rate.

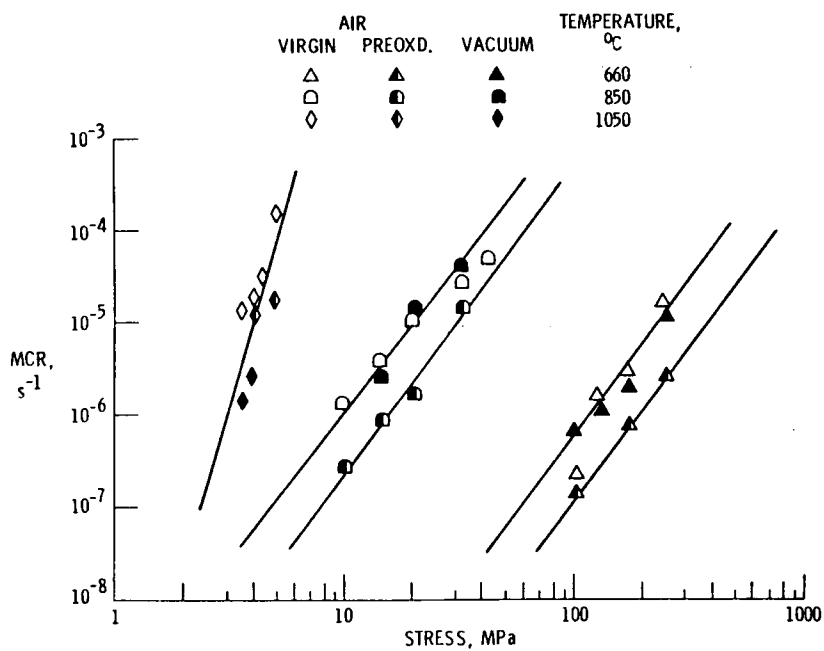
At 1050 C, the dependence of rupture live on stress level was much higher than at the lower temperatures, the stress exponent being roughly -12, rather than about -3. Also, the scatter in life was greater than for the lower temperature tests. Within this scatter, rupture lives could not be said to be different for tests of the virgin specimens in air or vacuum, or for the preoxidized specimens tested in air. However, as at the lower temperatures, the strain to fracture was much greater for tests of either the virgin or preoxidized specimens tested in air than for tests in vacuum.

# TYPICAL CREEP CURVES FOR NiCoCrAlY AT VARIOUS TEMPERATURES, STRESSLEVELS AND ENVIRONMENTS

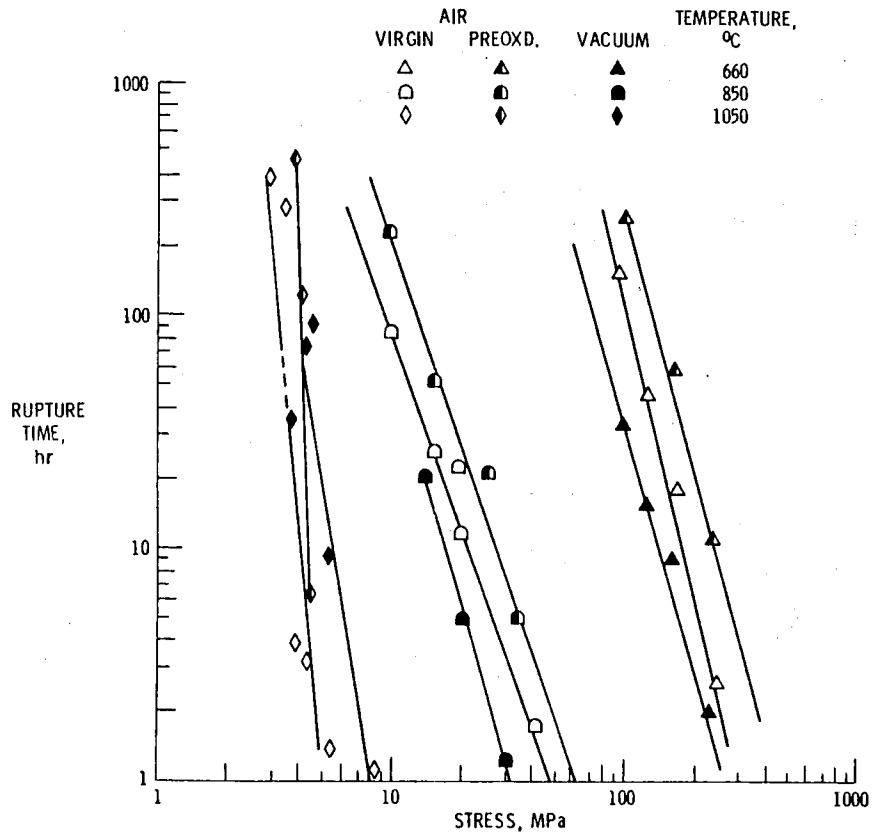


## MCR VERSUS STRESS

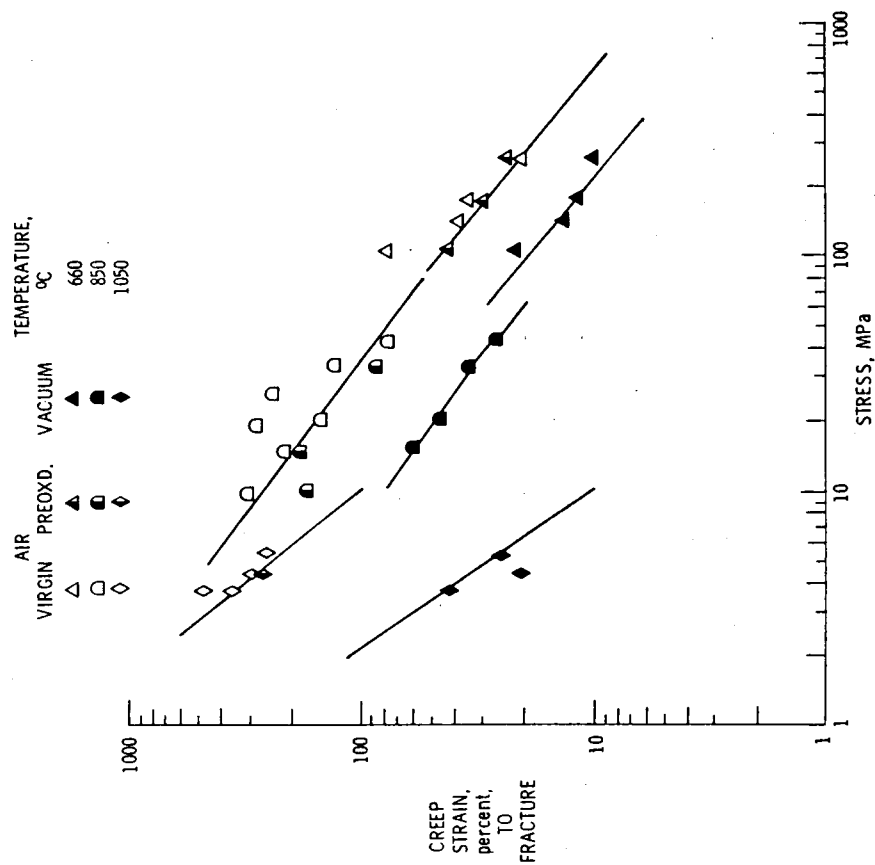
OF NiCoCrAlY AT VARIOUS TEMPERATURE AND ENVIRONMENT



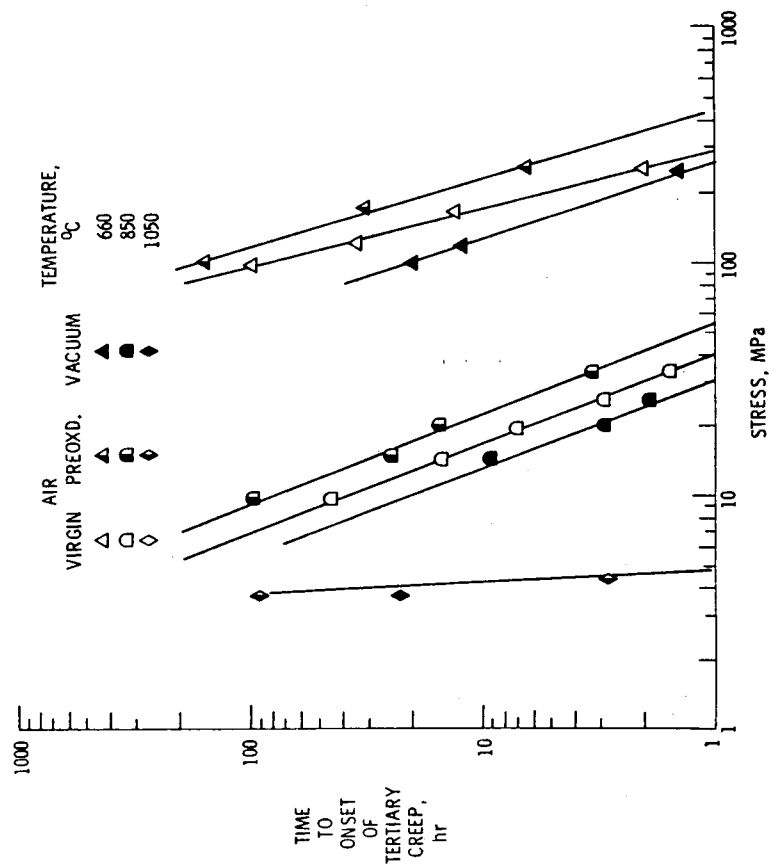
# STRESS DEPENDENCE OF TIME TO FAILURE OF NiCoCrAlY AT VARIOUS TEMPERATURES AND ENVIRONMENTS



# STRAIN TO FAILURE OF NiCoCrAlY AS A FUNCTION OF STRESS



# TIME TO THE ONSET OF TERTIARY CREEP OF NiCoCrAlY VERSUS APPLIED STRESS AT VARIOUS TEMPERATURES AND ENVIRONMENT



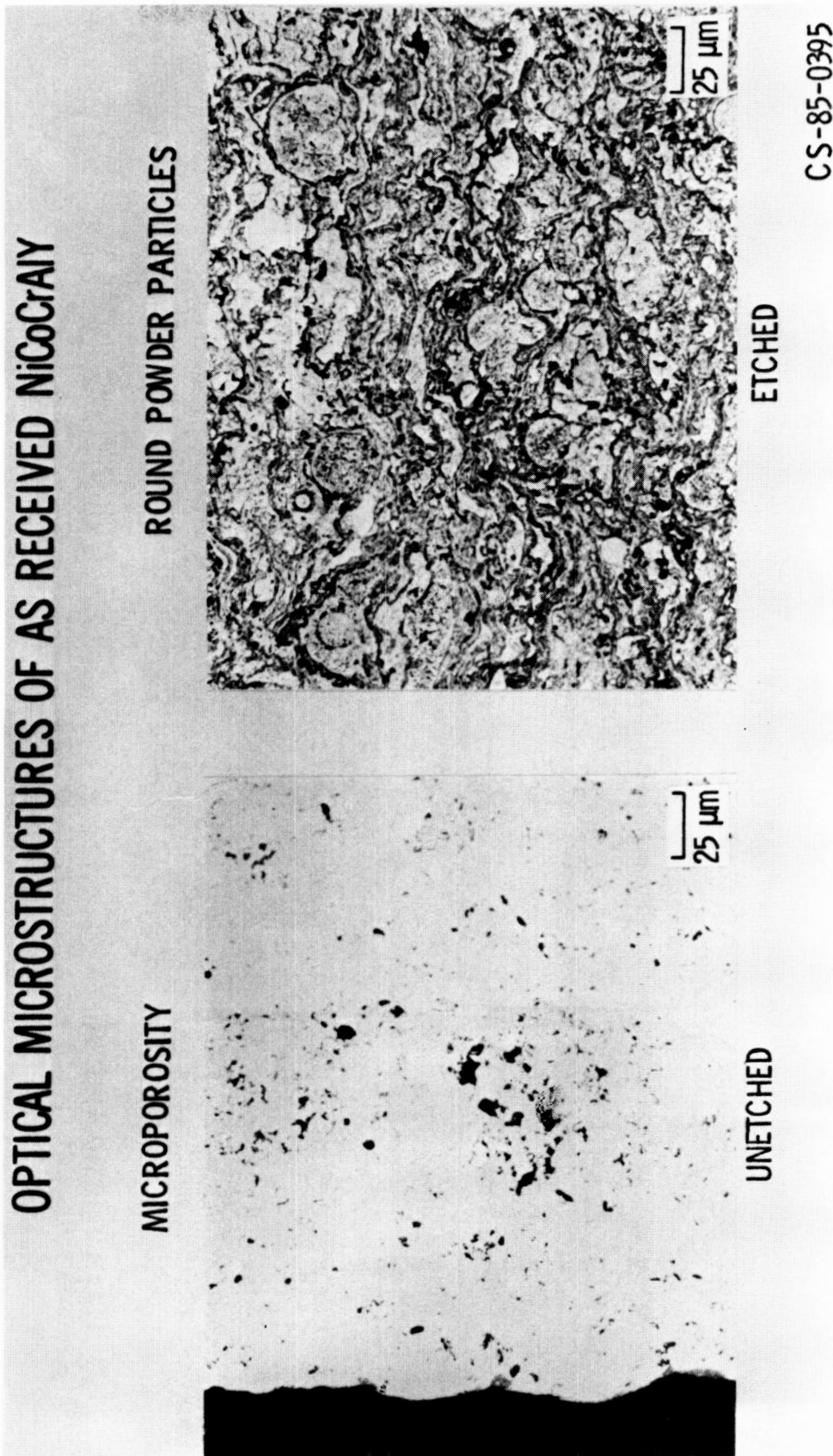
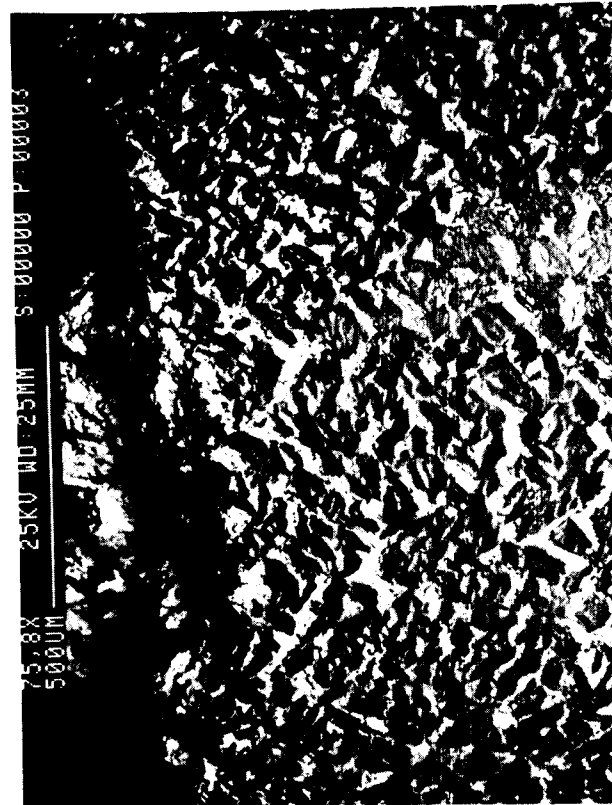
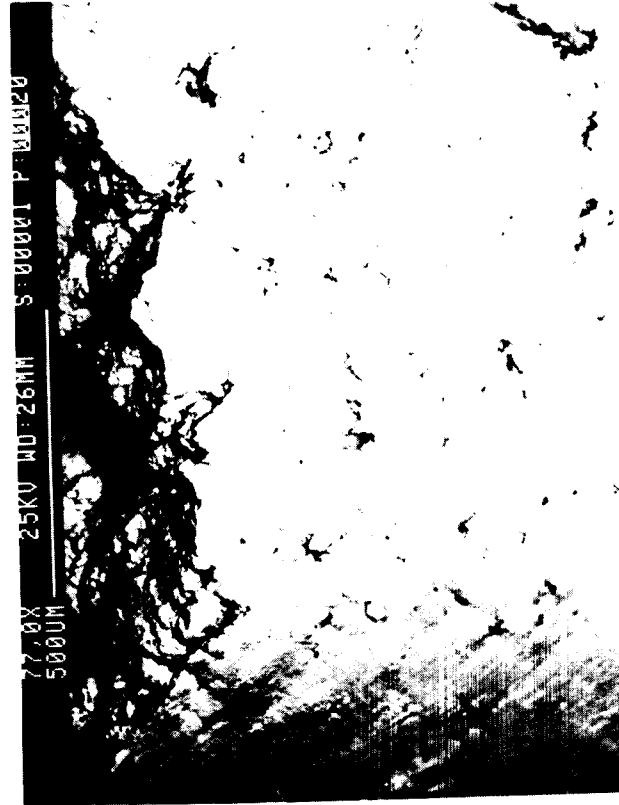


Figure 6.

# TYPICAL SURFACES OF CREEP TESTED SPECIMENS OF NiCoCrAlY



PREOXD /AIR



VIRGIN/ VACUUM

Figure 7.